PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-077513
(43)Date of publication of application : 14.03.2003

(51)Int.Cl. H01M 8/04

(21)Application number : 2001-268550
(22)Date of filing : 05.09.2001

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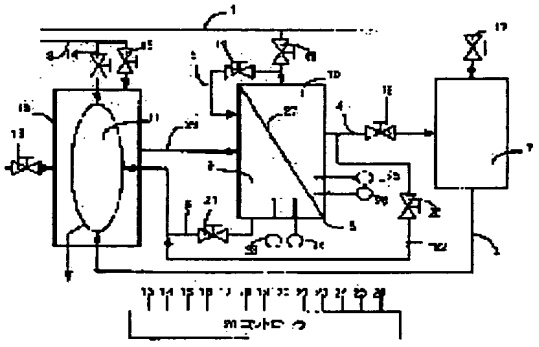
(54) FUEL REFORMING SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a stopping method for a reforming system to avoid hydrogen embrittlement of a hydrogen separating membrane under a low temperature.
SOLUTION: In this fuel cell reforming system, a fuel cell 7 to generate power by using hydrogen and oxygen, a reformer 12 to generate reformed gas containing hydrogen, and a hydrogen separator 8 having a hydrogen separating membrane 27 to transmit only hydrogen in the reformed gas generated by the reformer 12 to a transmitting side 10 from the reformed gas side 9 are provided, and hydrogen on the transmitting side 10 of the hydrogen separator 8 is supplied to the fuel cell 7. When stopping the fuel reforming system, generation of the reformed gas is stopped after partial pressures of hydrogen on the reformed gas side 9 and the transmitting side 10 of the hydrogen separator are equalized. As one method to equalize the partial pressures of hydrogen, a valve 19 on a pressure adjusting line 5 to link the reformed gas side 9 to the transmitting side 10 when the system is stopped is opened.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The fuel cell which generates electricity using hydrogen and oxygen, and the reforming machine which generates the reformed gas containing hydrogen, The hydrogen eliminator which has the hydrogen demarcation membrane which penetrates only the hydrogen in the reformed gas generated with said reforming vessel from a reformed gas side to a transparency side, In the fuel reforming system which supplied the hydrogen by the side of transparency of a preparation and said hydrogen eliminator to said fuel cell The fuel reforming system characterized by suspending generation of the reformed gas in said reforming machine after equalizing the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator, and transparency at the time of a halt of a fuel reforming system.
[Claim 2] The fuel cell which generates electricity using hydrogen and oxygen, and the reforming machine which generates the reformed gas containing hydrogen, The hydrogen eliminator which has the hydrogen demarcation membrane which penetrates only the hydrogen in the reformed gas generated with said reforming vessel from a reformed gas side to a transparency side, In the fuel reforming system which supplied the hydrogen by the side of transparency of a preparation and said hydrogen eliminator to said fuel cell Pressure regulation Rhine to which a reformed gas [of said hydrogen demarcation membrane] and transparency side is connected through a bulb, Hydrogen demarcation membrane exhaust air Rhine to which the reformed gas side of the combustor which burns an inflammable component, and said combustor and said hydrogen eliminator is connected through a bulb, The bypass line which connects the transparency side of said combustor and said hydrogen eliminator through a bulb, While intercepting supply of the hydrogen to said fuel cell at the time of a preparation and a fuel reforming system stop The fuel reforming system which suspends generation of said reformed gas after closing the bulb of said hydrogen demarcation membrane exhaust air Rhine and equalizing the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator, and transparency at the same time it opens the bulb of said pressure regulation Rhine, and the bulb of said bypass line.
[Claim 3] The fuel reforming system according to claim 2 which opens the bulb of said bypass line, and the bulb of said hydrogen demarcation membrane exhaust-air Rhine at the same time it opens the bulb of said purge line, and suspends generation of the reformed gas in said reforming machine further after it has the purge line which supplies air or inert gas to a reformed gas [of said hydrogen eliminator], and transparency side through a bulb and the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator and transparency becomes the same at the time of a halt of a fuel reforming system.
[Claim 4] Claim 2 which judges that equipped the transparency [of said hydrogen eliminator], and reformed gas side with the hydrogen concentration sensor and the pressure sensor, respectively, and the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator and transparency became equal with the hydrogen concentration and the pressure by the side of the reformed gas of said hydrogen eliminator, and transparency, or the fuel reforming system of any one publication of three.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the halt approach, concerning a fuel reforming system.
[0002]
[Description of the Prior Art] There are some to which platinum etc. is applied as a catalyst in the conventional fuel cell, and in order to avoid that this catalyst carries out poisoning, it will be necessary to remove the carbon monoxide produced from a hydrocarbon system fuel in the reforming reaction which generates hydrogen. Then, the method of removing a carbon monoxide by penetrating and separating only hydrogen from the reformed gas generated in the reforming reaction by the hydrogen demarcation membrane which used alloy film, such as metal membranes, such as Pd, V, Nb, and Ta, and Pd-Ag, Pd-V, is learned.
[0003] However, when transparency and separation of hydrogen were performed under the low temperature at the time of a system stop etc., such a hydrogen demarcation membrane had the problem of stiffening. The membranous brittle temperature and membranous pressure range in a hydrogen content pressure deficit and ambient temperature are shown in drawing 2 . Hydrogen embrittlement is closely related to temperature, and the use range of a hydrogen demarcation membrane was decided by temperature and the hydrogen partial pressure in the temperature requirement below fixed. Since hydrogen embrittlement occurs irrespective of a pressure under low temperature also in this drawing so that clearly, the problem that transparency and separation of the hydrogen under low temperature must be avoided arises.
[0004] As a conventional technique for solving such a problem, air is introduced into the reforming side of a hydrogen demarcation membrane at the time of a fuel cell system stop, and there is a fuel reforming system like JP,2001-118594,A which removes the hydrogen in a hydrogen demarcation membrane by making the hydrogen by the side of transparency of a hydrogen demarcation membrane reverse-penetrate to the reformed gas side of a hydrogen demarcation membrane.
[0005]
[Problem(s) to be Solved by the Invention] However, by such approach, when hydrogen demarcation membrane temperature fell during reverse transparency, there was a problem that a hydrogen demarcation membrane stiffened. Then, this invention aims at offering the fuel reforming system which can avoid embrittlement of the hydrogen demarcation membrane under the low temperature at the time of a system stop, in order to solve such a problem.
[0006]
[Means for Solving the Problem] The fuel cell with which the 1st invention generates electricity using hydrogen and oxygen, and the reforming machine which generates the reformed gas containing hydrogen, The hydrogen eliminator which has the hydrogen demarcation membrane which penetrates only the hydrogen in the reformed gas generated with said reforming vessel from a reformed gas side to a transparency side, In the fuel reforming system which supplied the hydrogen by the side of transparency of a preparation and said hydrogen eliminator to said fuel cell, after equalizing the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator, and transparency at the time of a halt of a fuel reforming system, generation of the reformed gas in said reforming machine is suspended.
[0007] The fuel cell with which the 2nd invention generates electricity using hydrogen and oxygen, and the reforming machine which generates the reformed gas containing hydrogen, The hydrogen eliminator which has the hydrogen demarcation membrane which penetrates only the hydrogen in the reformed gas generated with said reforming vessel from a reformed gas side to a transparency side, In the fuel reforming system which supplied the hydrogen by the side of transparency of a preparation and said hydrogen eliminator to

said fuel cell Pressure regulation Rhine to which a reformed gas [of said hydrogen eliminator] and transparency side is connected through a bulb, Hydrogen demarcation membrane exhaust air Rhine to which the reformed gas side of the combustor which burns an inflammable component, and said combustor and said hydrogen eliminator is connected through a bulb, The bypass line which connects the transparency side of said combustor and said hydrogen eliminator through a bulb, While intercepting supply of the hydrogen to said fuel cell at the time of a preparation and a fuel reforming system stop The bulb of said hydrogen demarcation membrane exhaust air Rhine is closed, and after equalizing the hydrogen partial pressure by the side of transparency of said hydrogen eliminator, and reformed gas, generation of said reformed gas is suspended at the same time it opens the bulb of said pressure regulation Rhine, and the bulb of said bypass line.

[0008] The 3rd invention is equipped with the purge line which supplies air or inert gas to a reformed gas [of said hydrogen eliminator], and transparency side through a bulb in the 2nd invention. After the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator and transparency becomes equal at the time of a halt of a fuel reforming system, The bulb of said bypass line and the bulb of said hydrogen demarcation membrane exhaust air Rhine are opened at the same time it opens the bulb of said purge line, and generation of the reformed gas in said reforming is suspended further.

[0009] In invention of the 2nd or 3, the 4th invention equips a transparency [of said hydrogen eliminator], and reformed gas side with a hydrogen concentration sensor and a pressure sensor, respectively, and judges that the hydrogen partial pressure by the side of the reformed gas of said hydrogen eliminator and transparency became the same with the hydrogen concentration and the pressure by the side of the reformed gas of said hydrogen eliminator, and transparency.

[0010]

[Function and Effect] According to the 1st invention, the hydrogen partial pressure of the both sides of a hydrogen demarcation membrane can be stopped by the same thing to do at the time of a fuel reforming system stop, without a hydrogen demarcation membrane carrying out hydrogen embrittlement, even if hydrogen exists, when the temperature of a hydrogen demarcation membrane falls.

[0011] Since the hydrogen partial pressure by the side of the reformed gas of a hydrogen eliminator and transparency can be equalized by opening the bulb of pressure regulation Rhine according to the 2nd invention, embrittlement of the hydrogen demarcation membrane under the temperature low temperature at the time of a fuel reforming system stop can be prevented.

[0012] Since according to the 3rd invention a hydrogen demarcation membrane can be cooled with air or inert gas where the hydrogen content pressure deficit by the side of the reformed gas of a hydrogen demarcation membrane and transparency is kept almost the same, before the hydrogen by the side of reformed gas and transparency goes away, even if it carries out sudden cooling of the film, hydrogen embrittlement does not arise. Moreover, ********** by the side of reformed gas and transparency is completely removable with a purge.

[0013] According to the 4th invention, it can judge correctly that the hydrogen partial pressure by the side of reformed gas and hydrogen became the same, and the amount of reformed gas consumed after a hydrogen partial pressure becomes the same before purging with air or inert gas can be reduced.

[0014]

[Embodiment of the Invention] The fuel reforming structure of a system in this operation gestalt is shown in drawing 1 .

[0015] The main configurations of this fuel reforming system consist of the reforming machine 12, the hydrogen eliminator 8, a fuel cell 7, and a combustor 11.

[0016] the fuel to which the reforming machine 12 adjusted the flow rate by the fuel control valve 13, and the air which adjusted the flow rate by the reforming machine air conditioning valve 15 from air supply Rhine 3 to a reforming reaction -- hydrogen -- rich reformed gas is generated. The reformed gas generated with the reforming vessel 12 is supplied to reformed gas side 9 of the hydrogen eliminator 8 through the reformed gas supply line 29. With the hydrogen demarcation membrane vessel 8, the hydrogen demarcation membrane 27 is minded, and only hydrogen is penetrated and separated from reformed gas side 9 transparency side 10. The air which adjusted the pressure by the fuel cell air conditioning valve 17 from the purge line 1 which carries out pressure regulation of the hydrogen gas penetrated and separated by the fuel cell hydrogen regulator valve 18, and supplies the anode plate (cathode electrode) of a fuel cell 7 through the hydrogen supply line 4, and supplies air is supplied to the cathode (anode electrode) of a fuel cell 7, and it generates electricity according to electrochemical reaction.

[0017] The hydrogen demarcation membrane exhaust gas of reformed gas side 9 which did not penetrate the

fuel cell exhaust gas of the surplus which was not used for the generation of electrical energy with the hydrogen eliminator 8 through fuel cell exhaust air Rhine 2 has a flow rate adjusted by the hydrogen demarcation membrane exhaust valve 21, and is supplied to a combustor 11 through hydrogen demarcation membrane exhaust air Rhine 6. In a combustor 11, heat required for the reforming reaction performed with the reforming vessel 12 is generated by burning using the air supplied through the combustor air conditioning valve 14 from these exhaust gas and air supply Rhine 3.

[0018] In order to prevent embrittlement of the hydrogen demarcation membrane 27 at the time of a system stop, the purge air open valve 16 for supplying the purge air or inert gas for sweeping away the hydrogen gas in the hydrogen demarcation membrane machine 8 from the purge line 1 is formed in transparency side of hydrogen eliminator 8 10.

[0019] Moreover, in order to adjust the pressure of reformed gas side 9 at the time of a fuel reforming system stop, and transparency side 10, pressure regulation Rhine 5 to which reformed gas side 9 is connected the purge line 1 top of the downstream of the purge air open valve 16 is formed, and the pressure open valve 19 is formed in pressure regulation Rhine 5. Furthermore, the bypass line 22 which connects the downstream of the hydrogen demarcation membrane exhaust valve 21 to the upstream of the fuel cell hydrogen regulator valve 18 on hydrogen demarcation membrane exhaust air Rhine 6 on the hydrogen supply line 4 is formed, and a bypass valve 20 is formed in the bypass line 22.

[0020] In the hydrogen eliminator 8, the transparency lateral pressure sensor 25 which measures the reformed gas lateral pressure sensor 23 which measures the pressure of reformed gas side 9, the reformed gas side hydrogen concentration sensor 24 which measures hydrogen concentration, and the pressure of transparency side 10, and the transparency side hydrogen concentration sensor 26 which measures hydrogen concentration are formed, and closing motion of each valve is controlled by the controller 28 to it based on the measurement result of these sensors.

[0021] In the fuel reforming system of such a configuration, the following control is performed so that the hydrogen demarcation membrane 27 may avoid hydrogen embrittlement at the time of a system stop.

[0022] In addition, during system operation, the fuel cell hydrogen regulator valve 18 and the reforming lateral pressure regulator valve 21 are opened, and the purge air open valve 16, the pressure open valve 19, and the bypass valve 20 are closed.

[0023] If the signal of a system stop is inputted into a controller 28 from the exterior, the hydrogen demarcation membrane exhaust valve 21 of hydrogen demarcation membrane exhaust air Rhine 6 and the fuel cell hydrogen regulator valve 18 of the hydrogen supply line 4 will be closed. It can come, simultaneously the pressure open valve 19 of pressure regulation Rhine 5 and the bypass valve 20 on a bypass line 22 are opened, and reformed gas side 9 of the hydrogen demarcation membrane machine 8 and transparency side 10 are opened for free passage.

[0024] The gas supplied to the hydrogen eliminator 8 is only reformed gas supplied to reformed gas side 9 through the reformed gas supply line 29 by this. Since the supplied reformed gas is supplied to an one direction from reformed gas side 9 transparency gas side 10, the hydrogen gas divided into transparency side 10 at the time of operation is discharged by the bypass line 22 and transparency side 10 is filled with reformed gas The hydrogen partial pressure of reformed gas side 9 and transparency side 10 can be equated.

[0025] In order to detect that the hydrogen partial pressure became equal correctly, the hydrogen partial pressure of reformed gas side 9 is computed with the pressure and hydrogen concentration which were measured by the reformed gas lateral pressure sensor 23 and the reformed gas side hydrogen concentration sensor 24. The hydrogen partial pressure of transparency side 10 is computed with the pressure and hydrogen concentration which were measured by the transparency lateral pressure sensor 25 and the transparency side hydrogen concentration sensor 26, and in order to suspend the fuel supply to the reforming machine 12, a fuel control valve 13 is closed in the place which corresponded.

[0026] Thereby, when a hydrogen partial pressure is unequal, since hot reformed gas is supplied to the hydrogen eliminator 8, embrittlement of the hydrogen demarcation membrane 27 can be prevented. Moreover, since the fuel supply to the reforming machine 12 can be suspended while a hydrogen partial pressure becomes equal, the consumption of a fuel can be reduced.

[0027] Next, the purge air open valve 16 is opened, in order to sweep away residual hydrogen and **********, purge air is introduced from the purge line 1, the hydrogen demarcation membrane exhaust valve 21 is opened to coincidence, and a part of reformed gas side 9 of the hydrogen demarcation membrane 27, transparency side 10, hydrogen supply line 4 and the residual hydrogen of pressure regulation Rhine 5, and ********** are removed.

[0028] The fuel cell hydrogen regulator valve 18 is closed at the time of a reforming system stop, and when

the pressure open valve 19 of pressure regulation Rhine 5 which connects reformed gas side 9 and transparency side 10 is opened, the gas constituents of reformed gas side 9 of the hydrogen demarcation membrane 27 and transparency side 10 are made the same and a hydrogen partial pressure is made into this **, it becomes impossible thus, for hydrogen to enter in the hydrogen demarcation membrane 27. Therefore, even if it cools the hydrogen demarcation membrane 27 under a hydrogen ambient atmosphere, the hydrogen embrittlement of the hydrogen demarcation membrane 27 is avoidable.

[0029] Then, since the residual hydrogen and ********** of reformed gas side of hydrogen eliminator 8 9 and transparency side 10 can be certainly removed by introducing air or inert gas into reformed gas side 9 and transparency side 10, without the hydrogen demarcation membrane 27 carrying out hydrogen embrittlement where a hydrogen partial pressure is mostly maintained at zero, it can prevent ********** flowing to a fuel cell 7 at the time of starting. Moreover, by the reformed gas lateral pressure sensor 23, the reformed gas side hydrogen concentration sensor 24 and the transparency lateral pressure sensor 25, and the transparency side hydrogen concentration sensor 26, since the hydrogen partial pressure of the both sides of the hydrogen demarcation membrane 27 is correctly detectable, the amount of generation of the reformed gas consumed after a hydrogen partial pressure becomes the same before purging with air or inert gas can be reduced.

[0030] In addition, it cannot be overemphasized that various modification can accomplish within the limits of the technical thought which this invention is not necessarily limited to the above-mentioned operation gestalt, and was indicated to the claim.

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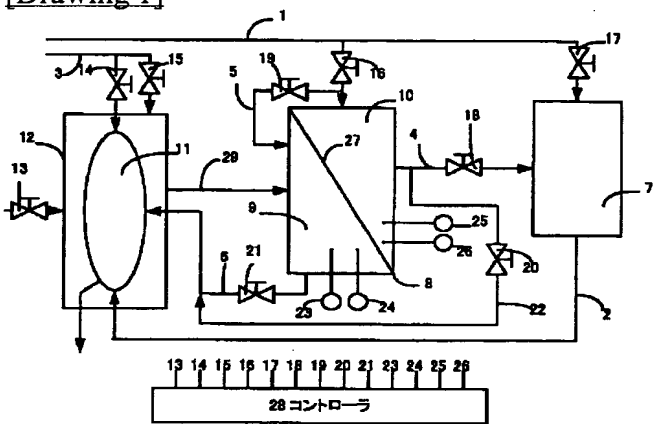
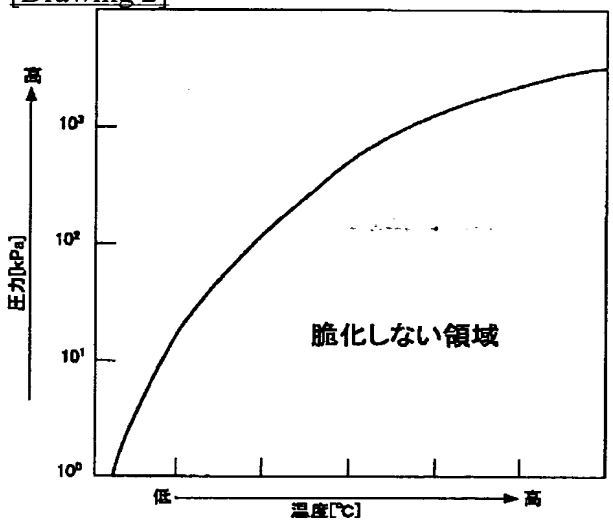
DRAWINGS

[Drawing 1]



[Drawing 2]



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(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2003－77513
（P2003－77513A）
(43)公開日　平成15年３月14日(2003.3.14)

(51)Int.Cl.⁷	識別記号	ＦＩ	ﾃｰﾏｺｰﾄﾞ(参考)
Ｈ０１Ｍ　8/04		Ｈ０１Ｍ　8/04	Ｙ　５Ｈ０２７

審査請求　未請求　請求項の数４　ＯＬ　（全５頁）

(21)出願番号　特願2001－268550(P2001－268550)

(22)出願日　平成13年９月５日(2001.9.5)

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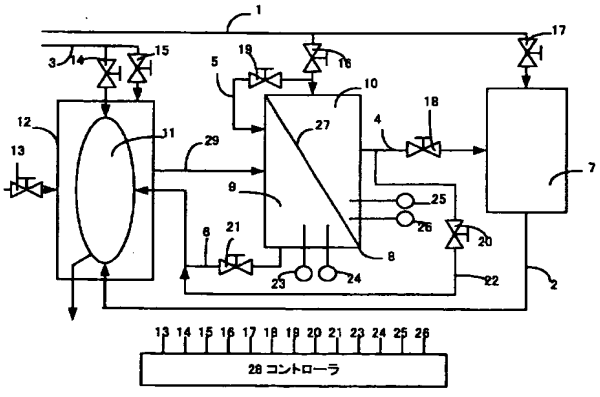
Ｆターム(参考)　5H027 AA02 BA01 BA09 BA16 KK01 KK31 MM01

(54)【発明の名称】　燃料改質システム

(57)【要約】
【課題】低温下における水素分離膜の水素脆化を回避する改質システムの停止方法を提供する。
【解決手段】水素と酸素を用いて発電を行う燃料電池７と、水素を含む改質ガスを生成する改質器１２と、改質器１２により生成された改質ガス中の水素のみを改質ガス側９から透過側１０に透過する水素分離膜２７を有する水素分離器８と、を備え、水素分離器８の透過側１０の水素を燃料電池７に供給するようにした燃料改質システムにおいて、燃料改質システムの停止時に水素分離器の改質ガス側９と透過側１０の水素分圧を同じにしてから改質ガスの生成を停止する。水素分圧を同じにする方法としては、システム停止時に改質ガス側９と透過側１０を連結する圧力調整ライン５上の弁１９を開くというものがある。



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【特許請求の範囲】
【請求項１】水素と酸素を用いて発電を行う燃料電池と、
水素を含む改質ガスを生成する改質器と、
前記改質器により生成された改質ガス中の水素のみを改質ガス側から透過側に透過する水素分離膜を有する水素分離器と、を備え、
前記水素分離器の透過側の水素を前記燃料電池に供給するようにした燃料改質システムにおいて、
燃料改質システムの停止時に前記水素分離器の改質ガス側と透過側の水素分圧を均等にしてから前記改質器での改質ガスの生成を停止することを特徴とする燃料改質システム。
【請求項２】水素と酸素を用いて発電を行う燃料電池と、
水素を含む改質ガスを生成する改質器と、
前記改質器により生成された改質ガス中の水素のみを改質ガス側から透過側に透過する水素分離膜を有する水素分離器と、を備え、
前記水素分離器の透過側の水素を前記燃料電池に供給するようにした燃料改質システムにおいて、
前記水素分離膜の改質ガス側と透過側をバルブを介して結ぶ圧力調整ラインと、
可燃成分を燃焼する燃焼器と、
前記燃焼器と前記水素分離器の改質ガス側をバルブを介して結ぶ水素分離膜排気ラインと、
前記燃焼器と前記水素分離器の透過側をバルブを介して結ぶバイパスラインと、を備え、
燃料改質システム停止時に、前記燃料電池への水素の供給を遮断する一方、前記圧力調整ラインのバルブと前記バイパスラインのバルブを開くと同時に、前記水素分離膜排気ラインのバルブを閉じて、前記水素分離器の改質ガス側と透過側の水素分圧を均等にしてから前記改質ガスの生成を停止する燃料改質システム。
【請求項３】前記水素分離器の改質ガス側と透過側に空気または不活性ガスをバルブを介して供給するパージラインを備え、
燃料改質システムの停止時に、前記水素分離器の改質ガス側と透過側の水素分圧が同じになった後、前記パージラインのバルブを開けると同時に前記バイパスラインのバルブと前記水素分離膜排気ラインのバルブを開け、さらに前記改質器での改質ガスの生成を停止する請求項２に記載の燃料改質システム。
【請求項４】前記水素分離器の透過側および改質ガス側にそれぞれ水素濃度センサと圧力センサを備え、前記水素分離器の改質ガス側と透過側の水素分圧が均等になったことを、前記水素分離器の改質ガス側と透過側の水素濃度と圧力により判断する請求項２または３のいずれか一つに記載の燃料改質システム。
【発明の詳細な説明】

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【０００１】
【産業上の利用分野】本発明は、燃料改質システムに関する、特にその停止方法に関する。
【０００２】
【従来の技術】従来の燃料電池には触媒として白金等が適用されているものがあり、この触媒が被毒するのを回避するために、炭化水素系燃料から水素を生成する改質反応において生じる一酸化炭素を除去する必要が生じる。そこで、Pd、V、Nb、Ta等の金属膜やPd-Ag、Pd-V等の合金膜を使用した水素分離膜により、改質反応において生成された改質ガスから水素のみを透過・分離することで一酸化炭素を除去する方法が知られている。
【０００３】しかしながら、システム停止時等の低温下で水素の透過・分離を行うと、このような水素分離膜は脆化するという問題があった。図２に水素分圧差と雰囲気温度における膜の脆化温度及び圧力範囲を示す。水素脆化は温度と密接に関係しており、一定以下の温度範囲では温度と水素分圧によって、水素分離膜の使用範囲が決まっている。この図においても明らかなように、低温下では圧力にかかわらず水素脆化が発生するので、低温下の水素の透過・分離を回避しなければならないという問題が生じる。
【０００４】このような問題を解決するための従来技術として、燃料電池システム停止時に水素分離膜の改質側に空気を導入し、水素分離膜の透過側の水素を水素分離膜の改質ガス側へ逆透過させることにより水素分離膜内の水素を除去する特開2001－118594のような燃料改質システムがある。
【０００５】
【発明が解決しようとしている問題点】しかしながら、このような方法では逆透過中に水素分離膜温度が低下すると、水素分離膜が脆化するという問題があった。そこで本発明は、このような問題を解決するために、システム停止時の低温下における水素分離膜の脆化を回避できる燃料改質システムを提供することを目的とする。
【０００６】
【問題点を解決するための手段】第１の発明は、水素と酸素を用いて発電を行う燃料電池と、水素を含む改質ガスを生成する改質器と、前記改質器により生成された改質ガス中の水素のみを改質ガス側から透過側に透過する水素分離膜を有する水素分離器と、を備え、前記水素分離器の透過側の水素を前記燃料電池に供給するようにした燃料改質システムにおいて、燃料改質システムの停止時に前記水素分離器の改質ガス側と透過側の水素分圧を均等にしてから、前記改質器での改質ガスの生成を停止する。
【０００７】第２の発明は、水素と酸素を用いて発電を行う燃料電池と、水素を含む改質ガスを生成する改質器と、前記改質器により生成された改質ガス中の水素のみを改質ガス側から透過側に透過する水素分離膜を有する

水素分離器と、を備え、前記水素分離器の透過側の水素を前記燃料電池に供給するようにした燃料改質システムにおいて、前記水素分離器の改質ガス側と透過側をバルブを介して結ぶ圧力調整ラインと、可燃成分を燃焼する燃焼器と、前記燃焼器と前記水素分離器の改質ガス側をバルブを介して結ぶ水素分離膜排気ラインと、前記燃焼器と前記水素分離器の透過側をバルブを介して結ぶバイパスラインと、を備え、燃料改質システム停止時に、前記燃料電池への水素の供給を遮断する一方、前記圧力調整ラインのバルブと前記バイパスラインのバルブを開くと同時に、前記水素分離膜排気ラインのバルブを閉じて、前記水素分離器の透過側と改質ガス側の水素分圧を均等にしてから前記改質ガスの生成を停止する。

【０００８】第３の発明は、第２の発明において、前記水素分離器の改質ガス側と透過側に空気または不活性ガスをバルブを介して供給するパージラインを備え、燃料改質システムの停止時に、前記水素分離器の改質ガス側と透過側の水素分圧が均等になった後、前記パージラインのバルブを開けると同時に前記バイパスラインのバルブと前記水素分離膜排気ラインのバルブを開け、さらに前記改質での改質ガスの生成を停止する。

【０００９】第４の発明は、第２または３の発明において、前記水素分離器の透過側および改質ガス側にそれぞれ水素濃度センサと圧力センサを備え、前記水素分離器の改質ガス側と透過側の水素分圧が同じになったことを、前記水素分離器の改質ガス側と透過側の水素濃度と圧力により判断する。

【００１０】

【作用及び効果】第１の発明によれば、燃料改質システム停止時に水素分離膜の両側の水素分圧を同じすることで、水素分離膜の温度が低下した時に水素が存在しても水素分離膜が水素脆化することなしに停止できる。

【００１１】第２の発明によれば、圧力調整ラインのバルブを開けることにより水素分離器の改質ガス側と透過側の水素分圧を均等にすることができるので、燃料改質システム停止時の温度低温下における水素分離膜の脆化を防止できる。

【００１２】第３の発明によれば、水素分離膜の改質ガス側と透過側の水素分圧差をほぼ同じに保った状態で水素分離膜を空気または不活性ガスで冷却できるので、改質ガス側と透過側の水素が出て行く以前に膜を急冷却しても水素脆化が生じることはない。また、パージにより改質ガス側と透過側の残改質ガスを完全に除去できる。

【００１３】第４の発明によれば、改質ガス側と水素側の水素分圧が同じになったことを正確に判断でき、水素分圧が同じになってから空気または不活性ガスでパージするまでに消費する改質ガス量を低減できる。

【００１４】

【発明の実施の形態】本実施形態における燃料改質システムの構成を図１に示す。

【００１５】本燃料改質システムの主な構成は、改質器１２、水素分離器８、燃料電池７、燃焼器１１から成る。

【００１６】改質器１２は、燃料調整弁１３により流量を調整した燃料と、空気供給ライン３から改質器空気調整弁１５により流量を調整した空気から、改質反応により水素リッチな改質ガスを生成する。改質器１２で生成した改質ガスを、改質ガス供給ライン２９を経て水素分離器８の改質ガス側９に供給する。水素分離膜器８では、水素分離膜２７を介して水素のみを改質ガス側９から透過側１０に透過・分離する。透過・分離した水素ガスを燃料電池水素調整弁１８により圧力調整し、水素供給ライン４を経て燃料電池７の陽極（カソード電極）に供給し、また、空気を供給するパージライン１から燃料電池空気調整弁１７により圧力を調整した空気を燃料電池７の陰極（アノード電極）に供給して電気化学反応により発電を行う。

【００１７】発電に使用されなかった余剰の燃料電池排気ガスは燃料電池排気ライン２を経て、また水素分離器８で透過しなかった改質ガス側９の水素分離膜排気ガスは水素分離膜排気弁２１により流量を調整されて水素分離膜排気ライン６を経て燃焼器１１に供給される。燃焼器１１では、これらの排気ガスと空気供給ライン３から燃焼器空気調整弁１４を介して供給された空気を用いて燃焼を行うことにより、改質器１２で行う改質反応に必要な熱を生成する。

【００１８】水素分離器８の透過側１０には、システム停止時の水素分離膜２７の脆化を防ぐために、水素分離膜器８内の水素ガスを一掃するためのパージ空気または不活性ガスをパージライン１から供給するためのパージ空気開放弁１６を設ける。

【００１９】また、燃料改質システム停止時の改質ガス側９と透過側１０の圧力を調整するために、パージ空気開放弁１６の下流側のパージライン１上と改質ガス側９を結ぶ圧力調整ライン５を設け、圧力調整ライン５に圧力開放弁１９を設ける。さらに、水素供給ライン４上で燃料電池水素調整弁１８の上流側と水素分離膜排気ライン６上で水素分離膜排気弁２１の下流側を結ぶバイパスライン２２を設け、そのバイパスライン２２にバイパス弁２０を設ける。

【００２０】水素分離器８には、改質ガス側９の圧力を測定する改質ガス側圧力センサ２３と水素濃度を測定する改質ガス側水素濃度センサ２４および透過側１０の圧力を測定する透過側圧力センサ２５と水素濃度を測定する透過側水素濃度センサ２６を設け、これらのセンサの測定結果に基づいてそれぞれの弁の開閉をコントローラ２８により制御する。

【００２１】このような構成の燃料改質システムにおいて、システム停止時に水素分離膜２７が水素脆化を回避するように以下のような制御を行う。

【００２２】なお、システム運転中は、燃料電池水素調整弁１８と改質側圧力調整弁２１を開け、パージ空気開放弁１６、圧力開放弁１９及びバイパス弁２０を閉じておく。

【００２３】外部よりシステム停止の信号がコントローラ２８に入力されたら、水素分離膜排気ライン６の水素分離膜排気弁２１と、水素供給ライン４の燃料電池水素調整弁１８を閉じる。これと同時に、圧力調整ライン5の圧力開放弁１９とバイパスライン２２上のバイパス弁２０を開いて、水素分離膜器８の改質ガス側９と透過側１０を連通する。

【００２４】これにより、水素分離器８に供給されるガスは改質ガス供給ライン２９を経て改質ガス側９に供給される改質ガスのみであり、供給された改質ガスは一方向に改質ガス側９から透過ガス側１０に供給され、運転時に透過側１０に分離されていた水素ガスはバイパスライン２２に排出され、透過側１０にも改質ガスが充満するので、改質ガス側９と透過側１０の水素分圧を均等化することができる。

【００２５】水素分圧が正確に均等になったのを検知するために、改質ガス側圧力センサ２３と改質ガス側水素濃度センサ２４で測定した圧力および水素濃度により改質ガス側９の水素分圧を算出し、透過側圧力センサ２５と透過側水素濃度センサ２６で測定した圧力および水素濃度により透過側１０の水素分圧を算出し、その両者が一致したところで、改質器１２への燃料供給を停止するために燃料調整弁１３を閉じる。

【００２６】これにより、水素分圧が不均等のときには、高温の改質ガスを水素分離器８に供給するので水素分離膜２７の脆化を防ぐことができる。また、水素分圧が均等になると同時に改質器１２への燃料供給を停止することができるので、燃料の消費量を低減することができる。

【００２７】次に、パージ空気開放弁１６を開き、残水素および残一酸化炭素を一掃するためにパージライン１からパージ空気を導入し、同時に水素分離膜排気弁２１を開き、水素分離膜２７の改質ガス側９と透過側１０、水素供給ライン４の一部および圧力調整ライン５の残水素、残一酸化炭素を除去する。

【００２８】このように、改質システム停止時に燃料電池水素調整弁１８を閉じ、改質ガス側９と透過側１０を結ぶ圧力調整ライン５の圧力開放弁１９を開いて水素分離膜２７の改質ガス側９と透過側１０のガス成分を同一にして水素分圧を同圧にすると、水素は水素分離膜２７内に入ることができなくなる。そのため、水素分離膜２７を水素雰囲気下で冷却しても水素分離膜２７の水素脆化を回避することができる。

【００２９】その後、改質ガス側９と透過側１０に空気、または不活性ガスを導入することにより、水素分圧

をほぼゼロに保った状態で、水素分離膜２７が水素脆化することなく水素分離器８の改質ガス側９および透過側１０の残水素・残一酸化炭素を確実に除去することができるので、始動時に残一酸化炭素が燃料電池７に流れることを防ぐことができる。また、改質ガス側圧力センサ２３と改質ガス側水素濃度センサ２４および透過側圧力センサ２５と透過側水素濃度センサ２６により、水素分離膜２７の両側の水素分圧を正確に検知することができるので、水素分圧が同じになってから空気または不活性ガスでパージするまでに消費する改質ガスの生成量を低減できる。

【００３０】なお、本発明は上記の実施形態に限定されるわけではなく、特許請求の範囲に記載した技術思想の範囲内で様々な変更が成し得ることは言うまでもない。

【図面の簡単な説明】

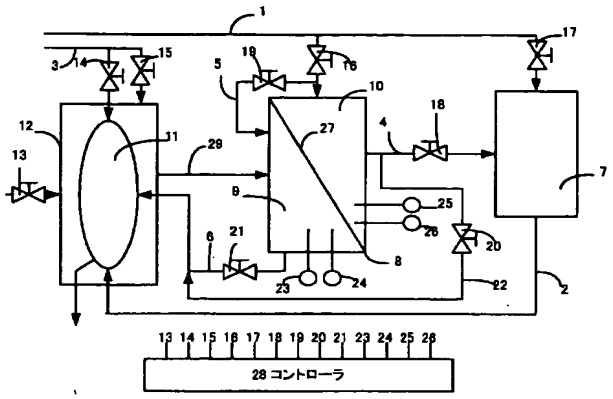
【図１】本実施形態における燃料改質システムの構成図である。

【図２】水素脆化の温度と水素分圧差の関係図である。

【符号の説明】

１　パージライン
２　燃料電池廃棄ライン
３　空気供給ライン
４　水素供給ライン
５　圧力調整ライン
６　水素分離膜排気ライン
７　燃料電池
８　水素分離器
９　改質ガス側
１０　透過側
１１　燃焼器
１２　改質器
１３　燃料調整弁
１４　燃焼器空気調整弁
１５　改質空気調整弁
１６　パージ空気開放弁
１７　燃料電池空気調整弁
１８　燃料電池水素調整弁
１９　圧力開放弁
２０　バイパス弁
２１　水素分離膜排気弁
２２　バイパスライン
２３　改質ガス側圧力センサ
２４　改質ガス側水素濃度センサ
２５　透過側圧力センサ
２６　透過側水素濃度センサ
２７　水素分離膜
２８　コントローラ
２９　改質ガス供給ライン

【図１】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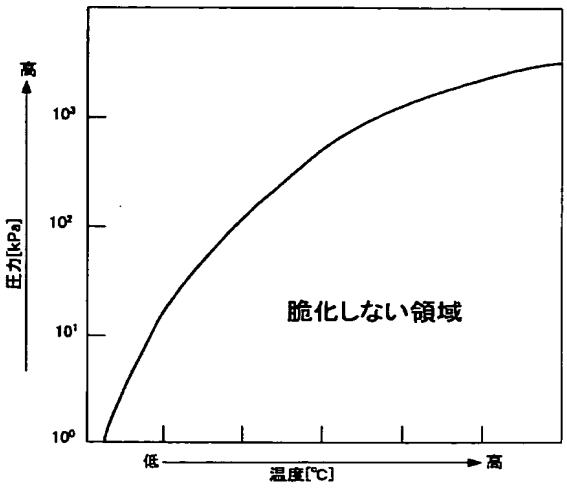
28 コントローラ

【図２】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10^3
10^2
10^1
10^0
脆化しない領域
低
高
温度[℃]